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Naming Convention for GLAST Tracker Construction and Tray Orientation in Tracker Tower

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Abstract

The GLAST tracker consists of many components such as about 10000 silicon strip detectors, 650 TMCM's (Tracker Multi-Chip Module formaly known as HDI, or a readout electronics unit), 300 detector trays, and so on. Since those components should be kept track of during assembly of the GLAST tracker, we need a consistent naming convention shared within the tracker construction team. In this document, I propose names of tracker components that we can use in the tracker construction database. Also, a specific tray orientation in a tracker tower is proposed for smooth connection between the strip name in the naming convention and the strip numbering in the global GLAST LAT coordinate system defined by the GLAST collaboration team.

1 Naming Convention

Naming convention and numbering scheme must be useful for the tracker construction, but at the same time, it should be easy to use in data acquisition software and in analysis/simulation software. For example, it should be easy and straightforward to look up measurement/test results during the construction to remove noisy strips from track fitting. On the other hand, however, it should not introduce any complexity nor confusion into tracker assembly processes. The naming convention described below is based largely on our experience on the BTEM (Beam-Test Engineering Module) tracker construction with several improvements based on such considerations.

The GLAST LAT coordinate system is defined elsewhere (See LAT-TD-003035-01 in CyberDoc at SLAC). It includes a numbering scheme that should be used inter-subsystem communications. The naming convention and numbering scheme proposed here does not conflict with the coordinate system, a part of which is also shown here for clarity. Note that the names and the numbers defined in this document should be used only within the tracker construction team. The LAT coordinate system should be used otherwise.

1.1 Naming Strategy

Two types of names are needed to keep track of tracker assembly: a component name and a location name. A component name corresponds to actual components of a tracker, such as a silicon strip detector, a TMCM, a tray, and so on. A location name is to specify a location of subcomponent of a certain component, such as a position of a detector in a ladder, a stack position of a tray in a tracker tower. For example, a detector at location "B" of ladder "LG0123" can be called "a detector at LG0123B", so you can say "DH04321 is assigned to LG0123B."

Definitions of component names and location names are proposed in sections below. Tables 1 and 2 list those names we propose.

1.2 Component Name

A component name consists of a component specifier, a component type, a manufacturer ID, and an ID number. All component names include a component specifier and an ID number, and some names include a component type and/or a manufacturer ID in addition. A component specifier is a single character to uniquely specify a component of tracker; for example "D" for detector and "M" for TMCM. A combination of a component type, a manufacturer ID, and an ID number specifies one physical object of that component. I propose component names as listed in Table 1.

1.3 Location Name

A location name is a suffix to a component name to specify a location of subcomponent which belongs to the component. Typical use of a location name is seen in assigning subcomponents to assemble onto a higher-level component, for example, assigning a ladder "LG1234" to a tray location "TGY123B2".

Another usage of location name is to specify an unnamed component, such as front-end chips, controller chips, bonding wires, and so on. For example, "M123F05" specifies a front-end chip on TMCM "M123" whose address is "5". So, you can say "M123F05 was replaced with a new chip." Another example is "S123C" specifying a bonding wire on location "C" on "S123", or the third wire from the readout side on the strip 123. With this expression, you can say "S123C was bonded twice" and so on.

See Table 2 for all the location names proposed here. Figures 1, 2, 3, and 4 shows the location names on major components.

Table 1. Tracker Component Names

Component	Name[a,b]	Remark
Strip	Snnn	nnn should match the number printed on a detector, with preceding zero(s) attached, i.e., 001 though 384. Use nnn = 000 and 385 for a bias ring for bonding purpose.
Detector	D$Mnnnnn$	M is a manufacturer ID. ID Number $nnnnn$ is not necessarily continuous because of rejects at the manufacturers.
Ladder	L$Mnnnn$	M is a manufacturer ID.
TMCM	Mnnn	
Kapton Cable	K$Tnnn$	T is a cable type: "A" through "D"
Tray	T$YMnnn$	M is a manufacturer ID, nnn is a close-out ID number, and Y a tray type: "G" for thin-converter trays (G for GLAST), "S" for thick-converter trays (S for SuperGLAST), "T" for top trays, "B" for bottom tray, "E" for no-converter tray (E for Empty).
Tower	Gnn	G for GLAST

a) n is a single digit integer forming an ID number of component.
b) M is a manufacturer ID: "H" for Hamamatsu, "S" for ST Microelectronics, "M" for Micron, "G" for G&A, "L" for Laben, "P" for Mipot, and "Y" for Hytec.

Table 2. Location Names

Location of		Name	Example
Detector	in Ladder	"A" through "D" "A" is the closest one to the readout electronics	LG0123B
Bonding wire	on Strip	"A" through "D" "A" is the closest one to the readout electronics	S123C
Front-end chip	on TMCM	"F0" through "F23" "F0" for the left-most[a] chip on a TMCM. An ID number (0–23) should match its front-end chip address.	M123F04
Controller chip	on TMCM	"R0" or "R1" "R0" for the left[a] one on a TMCM "R1" for the right[a] one	M123R0
Tray surface	on Tray	"F" or "B" "F" for the front side "B" for the back side (converter side)	TGY123F
Ladder	on Tray	"F0" through "F3" on the front side "B0" through "B3" on the back side Ladders at "F0" and "B0" connect the the left-most[a] front-end chip on a TMCM.	TGY123B2
Tray	in Tower	"tray 0" through "tray 18" "tray 0" is the back-most tray (the closest to the calorimeter module) and "tray 18" the front-most	G03 tray 8
Kapton Cable	on Tower	"C0" through "C8"	G05C3

a) The "left" side of a TMCM is defined as the left side in top view with front-end chips lined-up on the top of the TMCM (See also Figure 2).

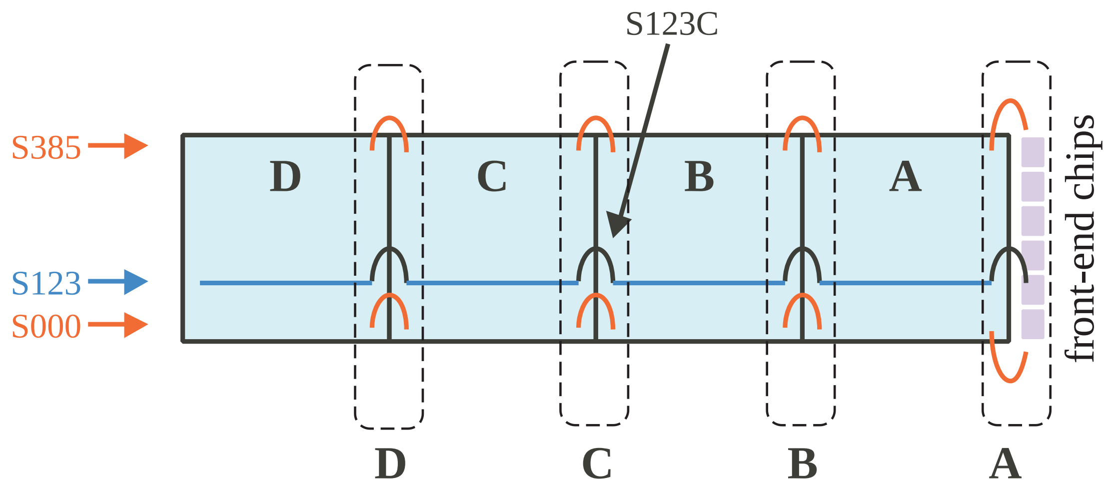

Fig. 1. Names of strips, bonding-wires, detector locations, and bonding rows.

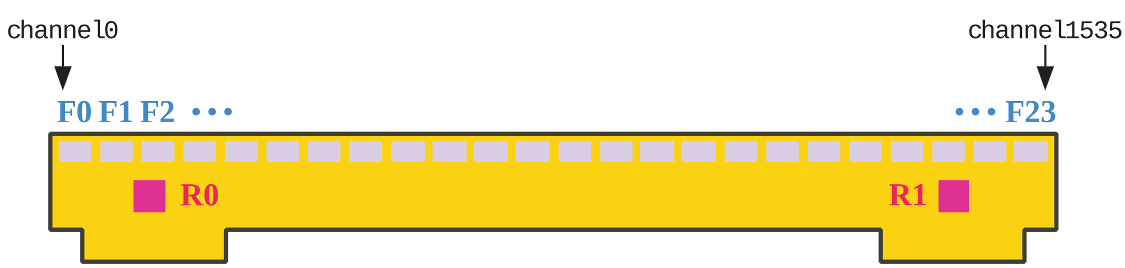

Fig. 2. Names of front-end chip locations and controller chip locations.

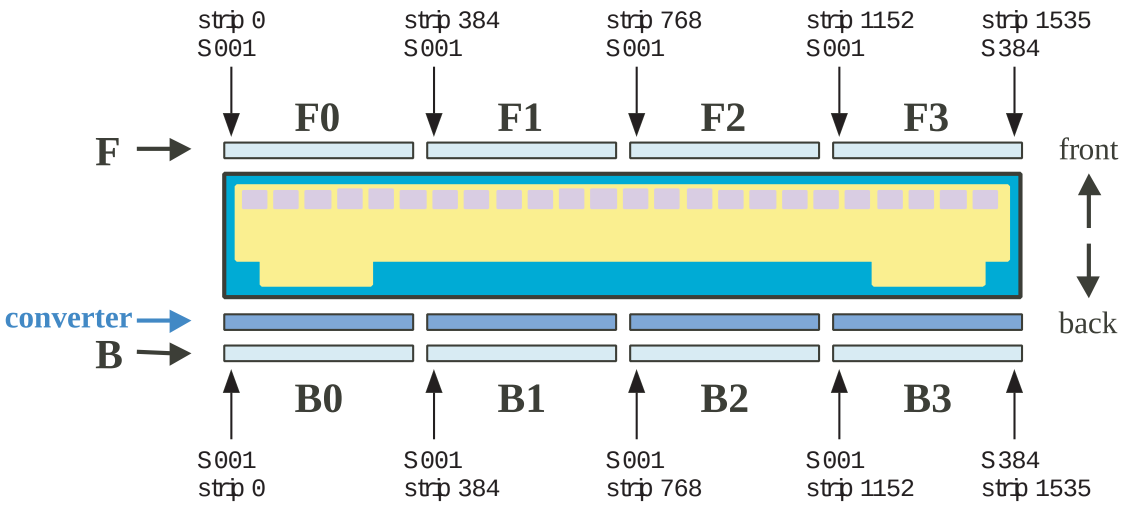

Fig. 3. Names of ladder locations and surfaces of a tray. Also, the figure shows strip names (Snnn) and strip numbers (0–1535) on a tray. Strip S001 of a ladder at F0 or B0 on a tray is strip 0 of the detector layer. And strip S384 of a ladder at F3 or B3 on a tray is strip 1535 of the detector layer. Note that the number in strip name is different from the strip number even on a ladder at “F0” and “B0” for some historical reasons.

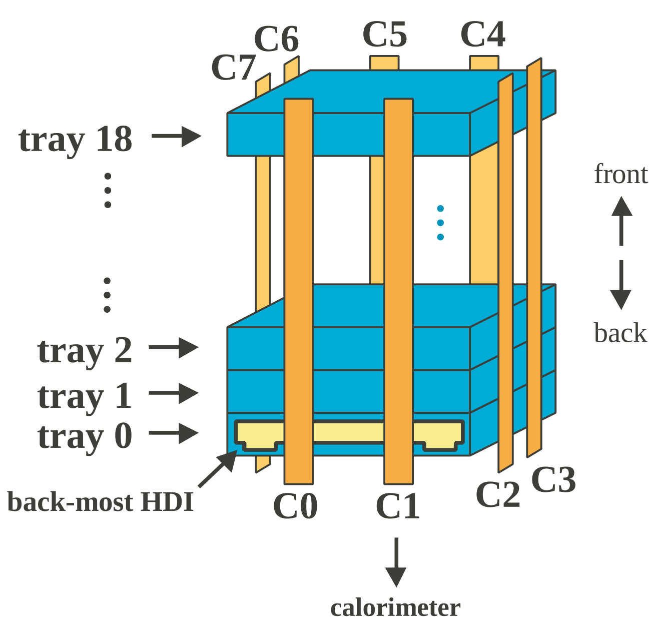

Fig. 4. Names of Kapton cable locations and stack positions of tray.

2 Tray Stack Orientation and Tracker Coordinate

The naming convention in the previous section should allow a simple conversion of bad strip information obtained during the construction into a bad strip list for data acquisition software and for analysis/simulation software to mask such strips. To minimize the complexity of the conversion, I propose to stack up trays in a specific orientation in a tracker tower. Also, the tray orientation described below enables the data acquisition software to calculate a hit location in tracker coordinate in a straightforward way. The first part of the section briefly explains the strip numbering scheme in the global LAT coordinate defined by the GLAST collaboration team.

2.1 Global Tracker Coordinate System

The global GLAST LAT coordinate system is defined for inter-subsystem communications (See LAT-TD-003035-01 in CyberDoc at SLAC). Summarized below is a part of the LAT coordinate system relating to the tracker construction.

Coordinate Axis The LAT coordinate system has X- and Y-axis on a detector plane, Z-axis pointing from back to front, where the back side of a tower is defined as the closest side to the calorimeter module. Another historical requirement is to have a Y-measuring detector layer at the top of a tower.

X- and Y-coordinate — strip numbering on a detector layer
A strip needs is numbered from 0 (zero) to 1535 on each detector layer for purposes of data acquisition and data analysis. Using the strip number, a strip can be called "strip 0" through "strip 1535" of a detector layer.

Z-coordinate — numbering of a detector plane in a tower
A detector plane is numbered from 0 (zero) to 17, from back to front, where a back-most plane means the closest to a calorimeter block. Using the detector plane number, a detector plane is called "XY0" through "XY17".
A detector layer can be uniquely identified by a combination of its measuring axis and a plane number. For example, X-measuring layer of XY13 is named "X13", Y-measuring layer of XY5 is "Y5", and so on.
Note that prefix "X" or "Y" is defined as its measuring axis, not as the axis its strips are running along. Strips of layer Xn is running along Y-axis, and those of layer Yn is running along X-axis, where n is a plane number (0 – 17).

2.2 Requirement on Tray Orientation in Tower

There are three constraints on orientation of trays in a tracker tower required by the GLAST LAT coordinate system.

1. The front-most layer measures Y-position of a track.
2. A strip number increases with X- or Y-coordinate.
3. The LAT coordinate system is right-handed.

Also, for testing purpose, it is desirable to assign strip numbers on a tray before the tray is stacked up into a tower. From assembly point of view, a following convention is helpful.

1. A strip number increases from the left side of a tray to the right, as shown in Figure 3.

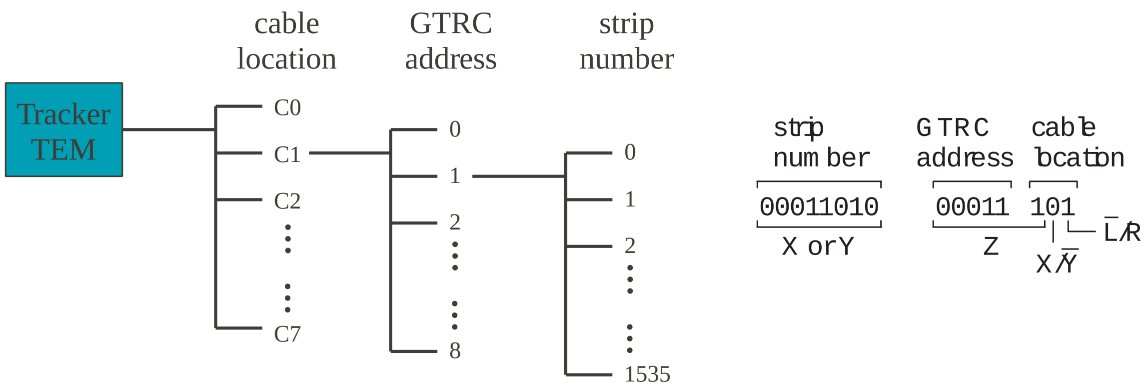

Fig. 5. A strip is identified uniquely in a tower by a combination of Kapton cable location, GTRC address and a strip number in a detector layer. In addition, a hit location in tracker coordinate (X or Y, and Z of a hit) can be easily calculated as shown in the figure.

With this convention, strip 0 of a detector layer is always connected to the left-most channel of a TMCM, which is channel 0 of front-end chip at "F0", independent of which surface of the tray that the TMCM reads out. This makes it easy to convert results from tests or measurements during the tracker construction into information needed in analysis, such as a list of noisy strips identified before the tray goes into a tower. Also, it will be easy to correlate noisy strips identified in analysis with a list of bad strips found in the construction.

Fortunately, all of these above can be satisfied simultaneously. Indeed, they uniquely determine orientation of all trays in a tower as shown in Figure 6.

2.3 Hit Location in Tracker Coordinate

For a TEM board to uniquely identify a "hit" in a tower, we use a combination of three numbers: a strip number on a detector layer with the hit, GTRC address of a TMCM that reads out the detector layer, and a location name of a Kapton cable connecting the TMCM (see a left diagram in Figures 5).

By definition, a strip number gives X- or Y-coordinate of a track immediately. Strip numbers on a detector layer is shown in Figure 3 and illustrated in Figure 6.

A pair of GTRC address and cable location tells us Z-coordinate of the hit, measuring axis (X or Y) of the layer, and physical location of the cable (right or left of towards the side of the tower). Once GTRC address and cable location are expressed in binary, one can extract those information as shown in the right of Figures 5.

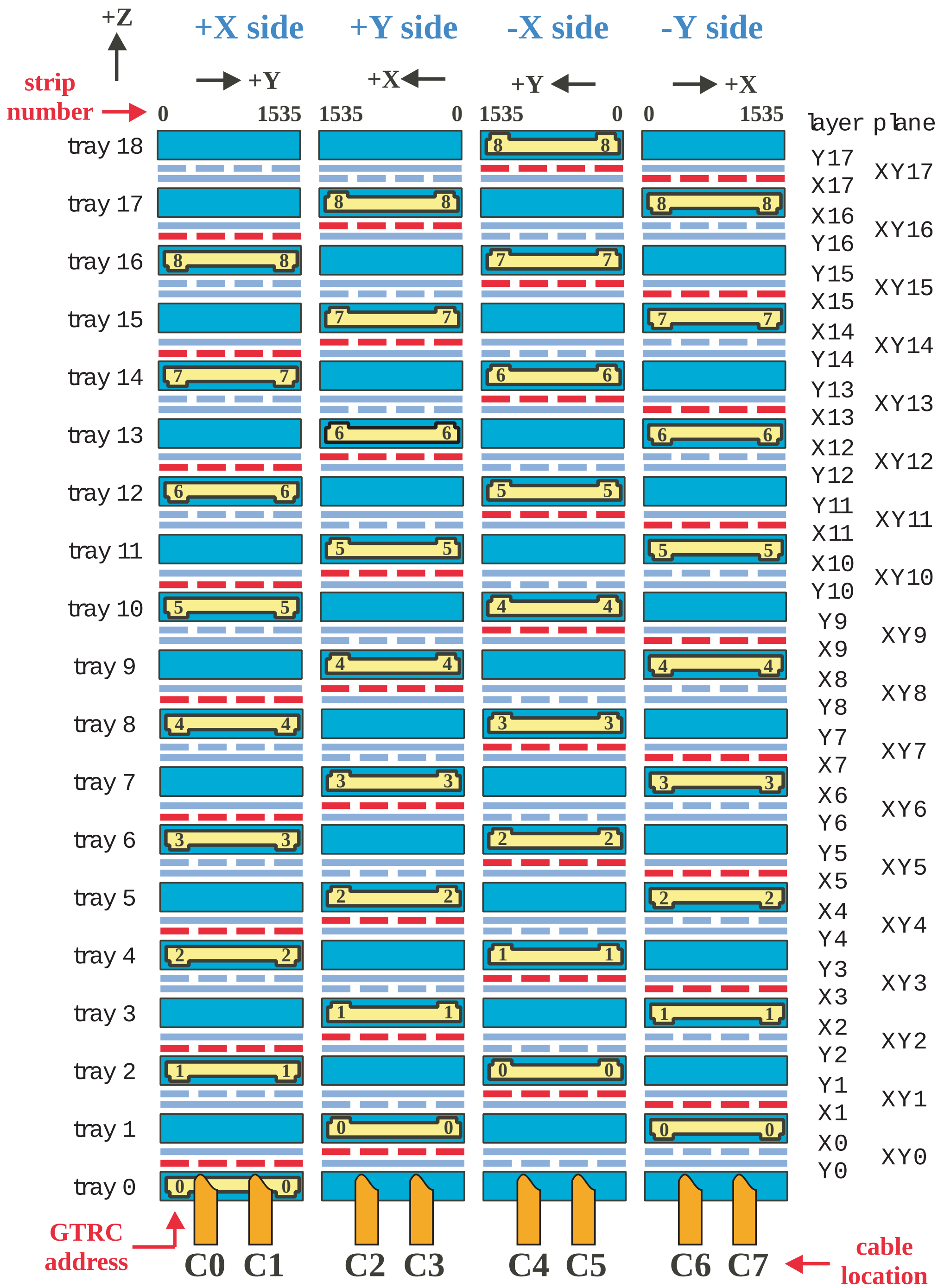

Fig. 6. Side views of a tracker tower, or definition of tray-stack orientation. Names of detector layers and detector planes are also shown. Horizontal bars between trays indicates a detector ladder; red (darker) one is the one to be readout on TMCM nearby (right below the layer or right above), and light blue (dimmer) one is the one not to be readout on that side. Also, it illustrates GTRC addresses, cable location names, and strip numbers, for use to identify a strip in a tower. GTRC address of each TMCM on a Kapton cable is hard-wired on a Kapton cable and ranges from 0 (zero) to 8.